K PUBLIC LIBRARY

DEC 9 1980

PUBS.

the human collision

THE HUMAN COLLISION

How injuries occur...
How seat belts prevent them.

ACKNOWLEDGMENT

The first edition of this publication was prepared, published, and distributed by the Ontario Ministry of Transportation and Communications in 1975. In publishing this second edition, the Department of Transport acknowledges the assistance of Kathryn Stephen, Lawrence Lonero and Terry Smutylo of the Research and Development Division of the Ministry of Transportation and Communications in revising and updating the text.

2nd Edition —
September, 1976

The United States Department of Transportation has obtained permission to reprint this document from the Canadian Government. This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

READEX FICHE

CONTENTS

INTRODUCTION

WHAT HAPPENS IN A COLLISION

The Car's Collision 1
The Human Collision 1
It's the Human Collision that Hurts 3
Person to Person 5

SEAT BELTS PREVENT THE HUMAN COLLISION

It's Not the Fall — It's the Stop at the End 6
How Much Can People Take? 6
How Do Seat Belts Work? 7
Emergency Locking Retractors 8
Laboratory Evidence 8
Evidence From Real Accidents 11
Mandatory Seat Belt Use 12

SEAT BELTS AND CHILDREN

Infants — Less than 20 Pounds 13
Children Between 20 and 40 Pounds 13
Older Children 14

IN ALMOST EVERY CASE IT'S BETTER TO WEAR SEAT BELTS

The Dangers of Being "Thrown Clear" 15
The Importance of Remaining Conscious 15
The Importance of Being Properly Belted 15
Are Belts Necessary at All Times? 16

PERSONAL RISK 17

BIBLIOGRAPHY

INTRODUCTION

The use of seat belts dramatically reduces the risk of injury and death. Scientific evidence strongly supports the value of seat belts, yet only a small proportion of people actually use them. People do not wear seat belts for a variety of reasons: fear that the seat belt will trap them in their cars; the belief that good drivers don't need them. Some people feel that they are just too much trouble.

This booklet provides information to help you decide, on the basis of the available scientific evidence, whether or not seat belts are worth the trouble it takes to use them.

WHAT HAPPENS IN A COLLISION

In recent years, motor vehicle collisions have been studied in an effort to reduce the severity of injuries. Ultra-slow-motion film and instruments for measuring forces have been used in these studies. As a result, we now have a good understanding of what happens to the car and to the people inside during a collision.

The Car's Collision

A standard kind of test crash involves running a remotely-controlled car straight into a solid concrete barrier. This is the simplest type of crash, and it is used as a standard or reference point for other test crashes and real accidents.

When a car strikes a solid object, it stops very abruptly. The front bumper is the first part of the car to come in contact with the barrier and it stops immediately. The front end crushes as the car comes to a complete stop.

At an impact speed of 30 miles per hour, the front of the car crushes about two feet and the car comes to a complete stop within one-tenth of a second. The crushing of the front end serves as a cushion for the rest of the car, and helps absorb the shock of the collision. As a result, the passenger compartment comes to a more gradual stop than the front of the car, and it remains undamaged by the collision.

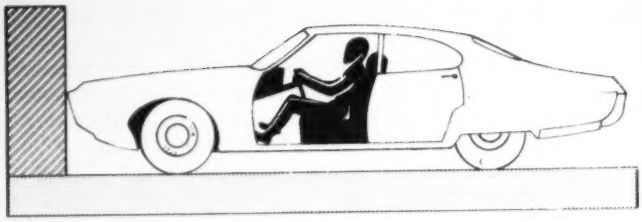
Even in severe collisions, the passenger compartment usually remains in good shape. If a collision occurs at an extremely high speed or if the car is hit broadside, the passenger compartment can be partially crushed. Fortunately, this happens in only a small minority of all collisions. In the great majority of accidents, the front or rear end of the car sustains most of the damage. The passenger compartment usually is not damaged at all by the vehicle's collision. Instead it is damaged by the person striking it with his head or body.

The Human Collision

It has become clear that there are really two kinds of collisions within a single accident. The first is the car's accident in which the car hits something, buckles and bends, and then comes to a stop. The second and more important collision is the "human collision" which happens when a person hits some part of the car. It is the human collision that causes injury.

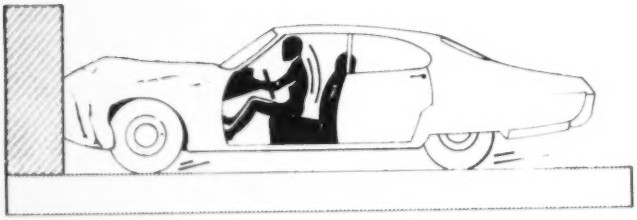
In the 30-mile per hour barrier crash, the car is crushed a couple of feet and comes to a stop about one-tenth of a second after hitting the barrier. Slow-motion film would show that the people keep moving inside the passenger compartment at 30 miles per hour. They continue moving inside the car during the one-tenth of a second that the car takes to stop. The people are still moving forward at their original speed when they slam into the steering wheel, windshield or some other part of the car. This is the human collision.

A test-track crash into a barrier at 30 mph.



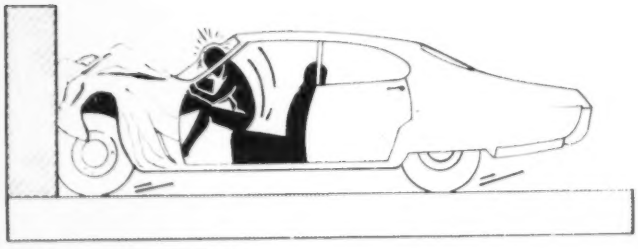
0.000 seconds - car hits barrier

On impact, the car begins to crush and to slow down. The person inside the car has nothing to slow him down so he continues to move forward inside the car at 30 mph.



0.050 seconds - car crushes

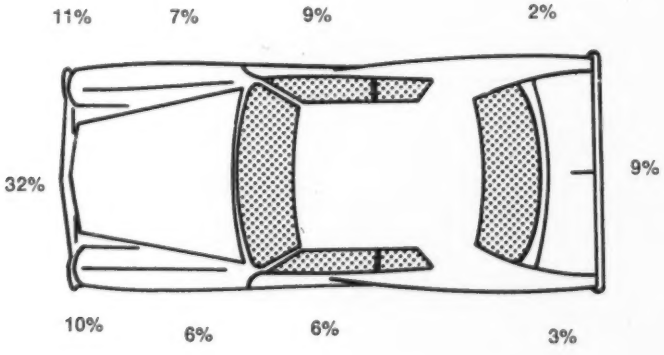
The car slows down as the crushing of the front end absorbs some of the force of the collision. The person inside is still moving forward at 30 mph.



0.100 seconds - car stops

0.120 seconds - person hits car interior

One-fiftieth of a second after the car has stopped, the person slams into the dashboard and windshield. This is the human collision. In the car's collision it takes 1/10 of a second to stop; in the human collision it takes only 1/100 of a second.



Percentages of Primary Impact in Urban Accidents

There are fewer side impacts in highway collisions (G. M. Mackay and C. P. de Fonseka, 1967)

Serious damage to the front end of this car resulted from a head-on crash. The windshield shows evidence of the human collision.

The interior of the car indicates that the passenger hit the windshield and dashboard. The driver bent the steering assembly with his chest.

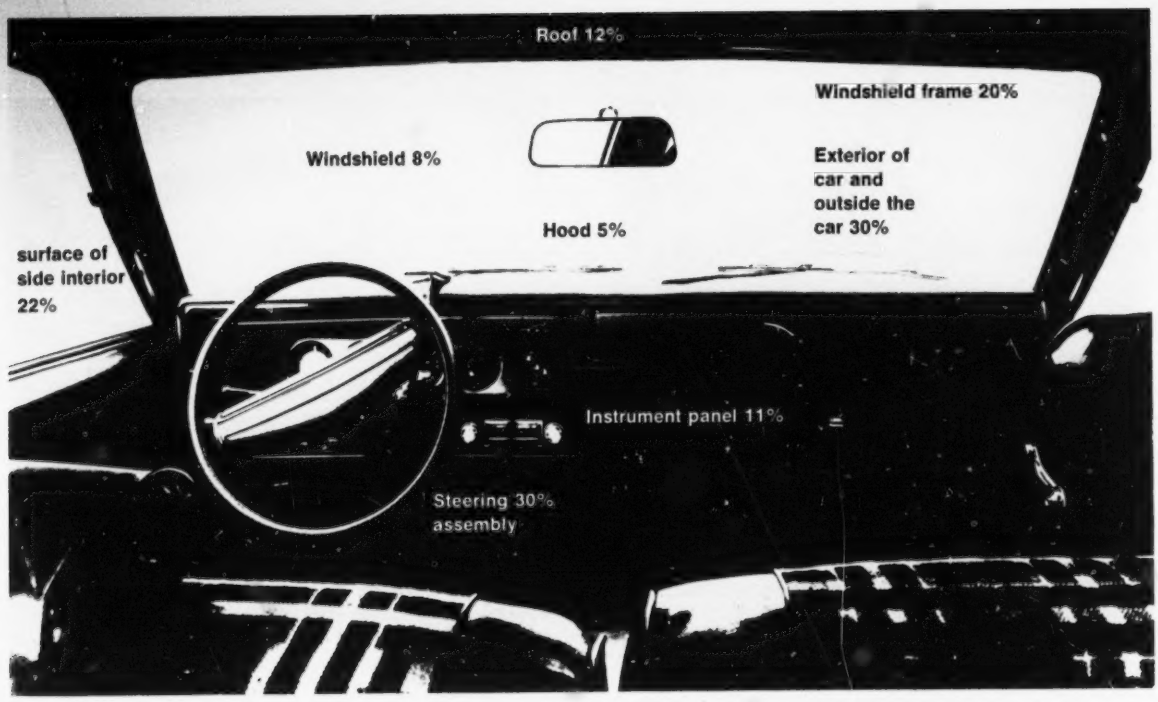
It's The Human Collision That Hurts

It is not easy to appreciate just how severe the human collision can be. To help understand what happens, imagine someone walking briskly head-first into a steel post. This would be about a 3 or 4-mile per hour human collision. The person would probably survive without serious injury. Then imagine him running full speed into the steel post. This would be about a 15-mile per hour collision. His injuries would be severe and he might not survive. Now imagine his head striking the post at 30 miles per hour. The force would be four times greater than at 15 miles per hour and the person would not survive. In a 30-mile per hour barrier crash, an occupant strikes the interior of the car with a force of several thousand pounds, causing serious injury to himself.

During a collision a person can strike the windshield, the windshield frame or a door post. All of these are hard and unyielding. When a person hits something hard he must come to a stop over a very short distance, one to two inches. Because the hard surface will give way very little, his body must absorb most of the force of the impact.

This car was struck on the right side near the front. The car door was bent by the driver who moved across the car toward the point of impact.

The interior of the same car shows that the unbelted driver hit the windshield pillar and as well the door. A human collision of this severity is usually fatal.



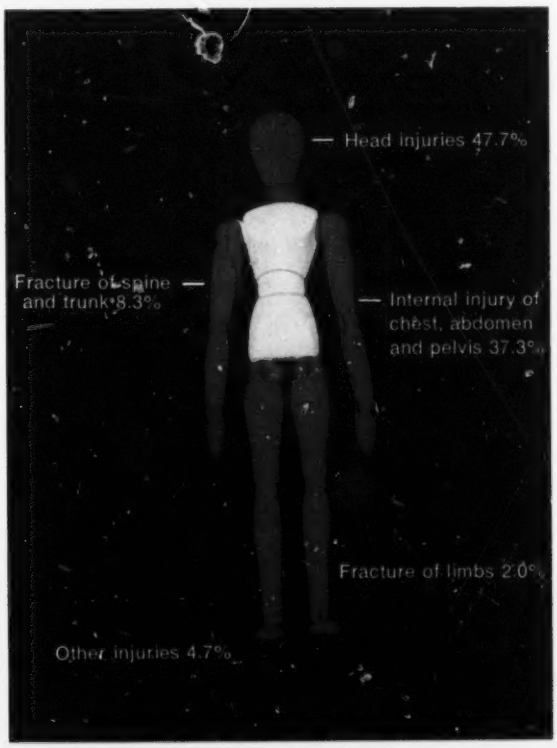
The above photo shows the percentage of occupants who were fatally injured by different objects inside the car. For example, the steering assembly caused fatal injuries to 30% of vehicle occupants killed in collisions. Frequently an occupant was injured by hitting more than one object. As a result, the percentages add to more than 100%. (Wilson and Savage, 1973)

Head and chest injuries are the most frequent cause of death in collisions. In Ontario about half of fatal accident victims die of head injuries. Severe injuries to the head and chest can result even in minor accidents. Chest injuries from the steering assembly are common in car accidents. Facial disfigurement often results from striking the windshield.

When an occupant strikes a hard edge, a knob or a lever in the car, all of the force of the impact is concentrated on only a small part of his body's surface. For example, gearshift levers have been known to penetrate the skull and cause death. Severe injury from hard or sharp objects can result even in a relatively minor crash.

If a person hits the steering wheel or a padded portion of the interior, some of the force is absorbed by the car. Except in very low-speed collisions, this will not be enough to protect the occupants from injuries. Padded dashboards and collapsible steering columns provide only a few inches of cushioning. If an occupant's head hits a well-padded dashboard at more than 30 miles per hour, serious injury will result.

Some people believe that they can protect themselves in a crash by holding onto the steering wheel, or bracing themselves with their arms or legs. Collisions usually happen too fast to permit this. Even if there is time to brace yourself, the forces involved in most collisions are too great to withstand, even at moderate speeds.


Head injuries 47.7%
Fracture of spine and trunk 8.3%
Internal injury of chest, abdomen and pelvis 37.3%
Fracture of limbs 2.0%
Other injuries 4.7%

Percentages of Fatal Injuries Sustained in Vehicle Collisions
Injuries to the head are the most frequent cause of death in vehicle collisions.

Person-To-Person

In a collision, passengers tend to move towards the point of impact, not away from it as might be expected. The tendency of everyone in the car to move in the same direction during a collision sometimes gives the term "human collision" special meaning.

In a frontal collision, people in the front seat can receive serious neck and spinal injuries from being struck by rear-seat passengers. Vehicle occupants can bump heads with fatal force. In a side collision a person can crash into the passenger next to him and force him out the window or door. During a collision people become high-speed projectiles, so it is not surprising that person-to-person contact is a common source of injury.

People often carry young children on their laps while riding in a car. This can lead to another form of human collision. Accident studies have shown that mothers can crush their children against the dashboard during a crash. Even in a relatively minor accident or panic stop, a child can be pulled away with surprising force and hit the dashboard or floor.

In a crash or sudden stop, an adult can crush a child against the dashboard.

SEAT BELTS PREVENT THE HUMAN COLLISION

It's Not the Fall — It's the Stop at the End

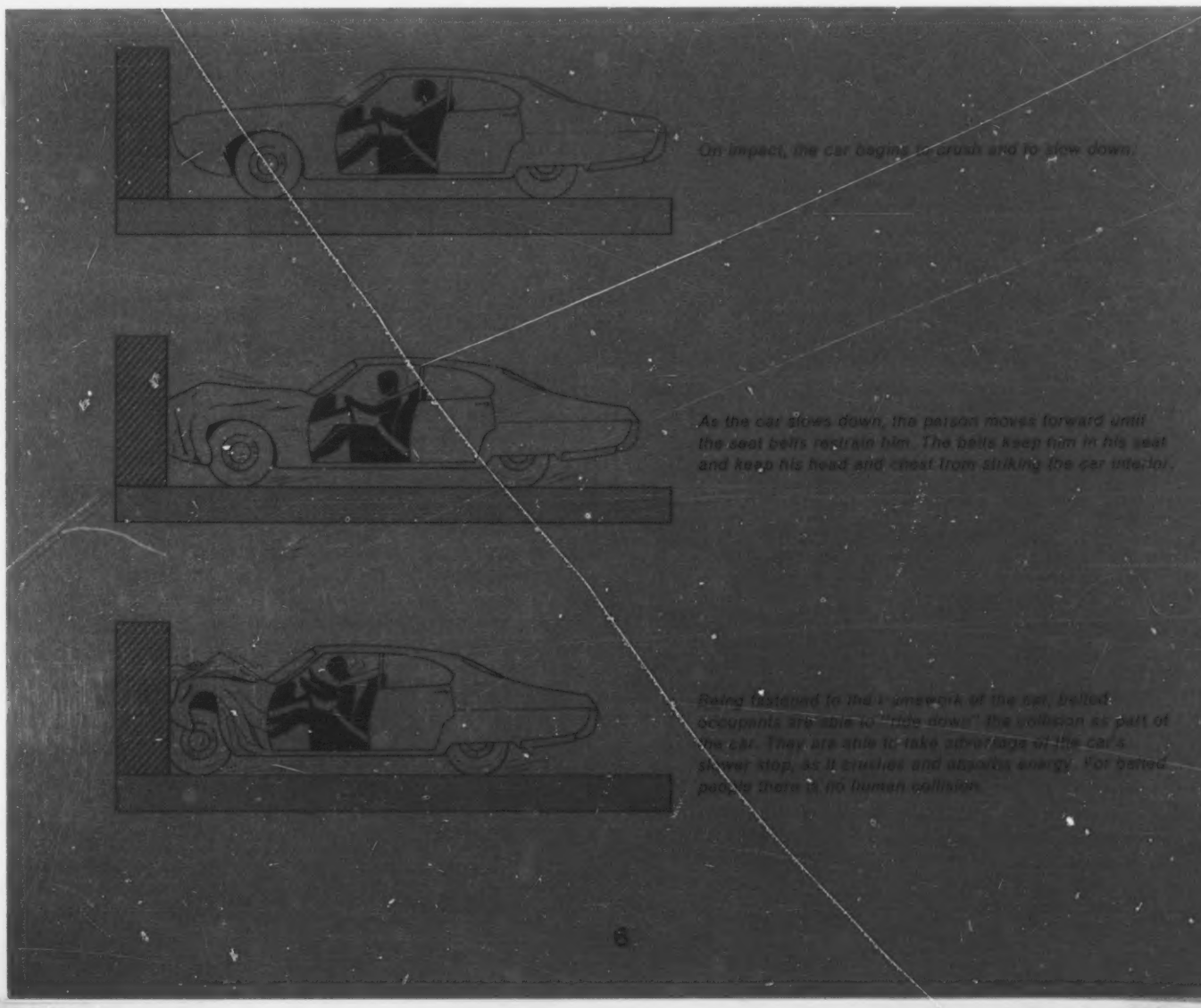
The first attempts to research the human body's ability to withstand crash forces were begun in the early 1940s by Hugh DeHaven. During investigations of air crashes, he became interested in "miraculous" survivals. This interest led DeHaven to look for other instances of survival of severe impacts. He studied cases in which people had survived falls from high places. Through analysis of these "freefall" case histories, he demonstrated that under proper circumstances the body could withstand extreme impact forces.

In each case of freefall survival, the person landed on something like soft ground or an automobile roof, something that absorbed some of the force created by the fall. When the person landed, the surface gave way a few inches. These few inches allowed a more gradual stop than if the landing had been on a hard surface. If the person landed on a large portion of his body (flat on his back for example), the force of the fall was distributed more evenly across the surface of his body. As a result, the person's injuries were less severe.

DeHaven concluded that injury could be reduced if the forces of an impact were spread out over time and space. In fact, spreading out the forces of the impact — and stretching them out over just a few hundredths of a second — could make the difference between life and death. He suggested that improved interior design and restraining devices, such as seat belts, would serve to stretch out the impact of a collision and to distribute its forces over the stronger parts of the body. His ideas were eventually adopted in both automobile and aircraft designs.

How Much Can People Take?

Others took up DeHaven's interest in the ability of the human body to tolerate crash forces. Colonel


On impact, the car begins to crush and to slow down.
As the car slows down, the person moves forward until the seat belts restrain him. The belts keep him in his seat and keep his head and chest from striking the car interior.
Being fastened to the framework of the car, belted occupants are able to "ride down" the collision as part of the car. They are able to take advantage of the car's slower stop, as it crushes and absorbs energy. For belted people there is no human collision.

John Stapp of the U.S. Air Force was one of the first to initiate scientific testing of DeHaven's observations. In the 1950s he developed various crash simulators to test the upper limits of tolerance to the forces of deceleration. The best known of these was a high-speed rocket sled capable of speeds greater than 600 miles per hour.

Stapp's experiments showed that when properly belted, subjects could tolerate impacts that would otherwise cause serious injury. He demonstrated scientifically that many serious automobile and aircraft accidents could be survived without serious injury if seat belts were worn to restrain the occupants. The findings of DeHaven and Stapp soon led automobile manufacturers to offer seat belts as optional safety equipment.

How do Seat Belts Work?

In a 30-mile per hour crash test, the car takes about two feet to come to a stop. This is a fairly abrupt stop. As mentioned in the discussion of the human collision, the occupants usually stop over a much shorter distance, perhaps one to two inches. This difference in stopping distance means that the occupants will stop much more abruptly than the car. To allow the person to come to a more gradual stop, all of the *car's* stopping distance has to be used. Holding the person in his seat with belts allows him to stop within about the same distance as the car. As a result, the forces on the body are greatly reduced.

The difference between the belted person's stopping distance and the unbelted person's stopping distance is often the difference between life and death. This is like the difference between one of DeHaven's fall victims landing on a sidewalk or in garden soil. The soft ground gives the person a few inches in which to come to a stop. Seat belts give the person in the car an additional couple of feet in which to stop.

The lap belt keeps a person inside the car, protecting him from the many dangers of being thrown out of the car. Even if used alone, the lap belt usually keeps the head from striking the windshield or windshield frame. It allows the body to bend forward so that the head hits only the steering wheel or dashboard. These parts of the car are designed to absorb energy and although their cushioning effect is somewhat limited, they cause much less damage than harder structures. The lap belt allows the hips to absorb much of the force of the collision and thus reduces the force that the head or chest must absorb in hitting the steering wheel or dashboard.

The shoulder belt prevents the head from hitting the steering wheel or dashboard. The shoulder belt provides a great deal of extra protection, particularly in preventing injuries to the head and face. These are very dangerous and disfiguring injuries. The shoulder belt prevents these injuries by restraining the upper part of the body, keeping the head from hitting the interior of the car.

Many people find the shoulder belt uncomfortable and inconvenient when they first start using their belts, particularly in older cars with separate shoulder belts. In order to prevent the injuries to the head and face, it is worth the trouble to wear the shoulder belt whenever possible. *A shoulder belt should never be worn without a lap belt.*

HOW CAR-SENSITIVE EMERGENCY LOCKING RETRACTORS OPERATE

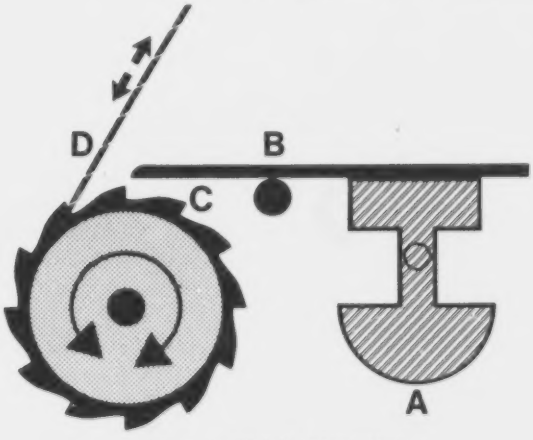


Figure 1 — NORMAL CONDITIONS

The majority of car-sensitive retractors use a pendulum (a) to sense an emergency condition and a bar (b) and ratchet (c) mechanism to lock the seat belt (d) in place.

Figure 1 — Under normal driving conditions the pendulum and bar in their normal rest positions. The reel which holds the belt is free to rotate. As the occupant moves forward, say to reach out to operate controls on the dashboard, the belt will move with the occupant.

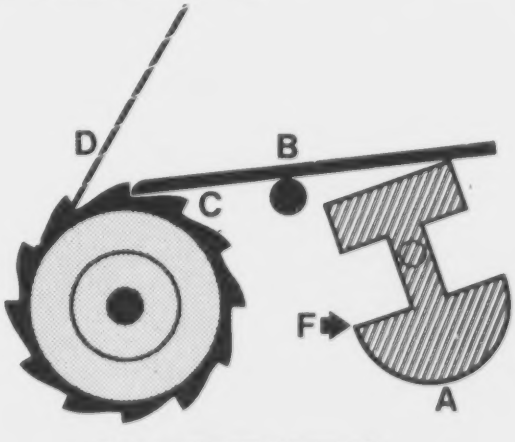


Figure 2 — EMERGENCY CONDITIONS

Figure 2 — Under emergency conditions, such as in a collision, the pendulum will move forward under the force of the impact (f) causing the bar to engage the ratchet. The reel and seat belt are now locked in place and the occupant is held firmly in his seat.

Together, the lap and shoulder belts work to keep a person in his seat and to distribute the force of the collision over the hips and shoulders — the parts of the body that can best withstand the force.

Emergency Locking Retractors

All cars manufactured after January 1, 1974 and sold in Canada are required by Canada Motor Vehicle Safety Standards to be fitted with special seat belts in both outer front seat positions. These are one-piece lap and shoulder belts which have emergency locking retractors.

A retractor is the device which winds up the slack in a loose or unused seat belt. Under normal driving conditions, this system allows belted occupants freedom to bend forward and sit comfortably in the car. A person who is wearing the seat belt can, for example, reach out and operate controls mounted on the dashboard. The shoulder part of the belt will pull out as the person moves forward, and will be pulled back by the retractor when the person returns to the normal seating position. Only in an emergency, such as a panic stop or a collision, will the retractor automatically lock and hold the person in his seat. This is why these types of retractors are called "emergency locking".

There are two types of emergency locking retractors: belt-sensitive and car-sensitive. Both types automatically lock in a collision, but the way each does this is different.

A belt-sensitive retractor locks when it senses any quick movement of the shoulder belt. In a collision, a belted person would move forward very quickly and produce such a movement of the belt. There is a very simple test to check if your car has belt-sensitive retractors and if they are working properly. Hold the shoulder part of the seat belt and give it a very sharp tug. The belt should lock before it has pulled out more than a couple of inches.

If the belt does not lock in this test then it may mean that you have car-sensitive retractors. These retractors lock only when they notice any quick change in the motion of the car. Most seat belts in new cars use these retractors. The operation of this type of retractor can be checked with the following road test. It should be attempted only on a dry level area with no traffic nearby. Do not try this test on wet, muddy, or icy roads:

(1) Properly fasten the seat belt;
(2) Start engine and drive in a normal manner until your speed reaches about 5 m.p.h.;
(3) Make sure that it is safe to brake and, if so, brake sharply. You should feel the belt lock and hold you firmly in your seat.

Your owner's manual will usually identify which type of retractor is in your car and give instructions to check its operation.

Laboratory Evidence

Since the early research showed that seat belts could reduce injuries in automobile accidents, further research has gone into the testing and development of seat belt systems. A large body of evidence for the value of seat belts comes from different types of studies, all of which agree that seat belts greatly reduce injury and death. These studies include laboratory testing, controlled test-track crashes, on-the-scene accident investigations and investigations of accident records.

To simulate a real-life crash in a laboratory setting, dummies have been built to approximate the human body. The dummies ride in a crash simulator sled, a structure similar to that of a car frame. The sled runs along a track and is controlled so that it can be accelerated and stopped suddenly. In this way, the dummies can be subjected to forces similar to those that people experience in automobile accidents. The simulated crashes are filmed in ultra-slow-motion to enable observation of what actually happens to the dummies in the crash. Instruments inside the dummies record the impact on various parts of the body.

This type of crash simulator sled uses an actual car body. The sled is controlled so that it can be accelerated and stopped suddenly to simulate the forces that occur in real collisions.

Test-track crashes are conducted using instrumented dummies and vehicles that are remotely controlled. Each car carrying belted or unbelted dummies is driven into another vehicle or a solid barrier. After each controlled crash, the instrument records and slow-motion film are examined to find out what happened to the car and to each of the dummy occupants. Sled tests with human volunteers have been used to verify the beneficial effects of seat belts.

This is a laboratory simulation of an 11 mph crash. The human volunteer is safely belted in his seat but the unbelted dummy has moved forward and struck his head on the steel windshield frame and glass.

It's hard to believe that a crash at 11 mph could have serious consequences like this.

1

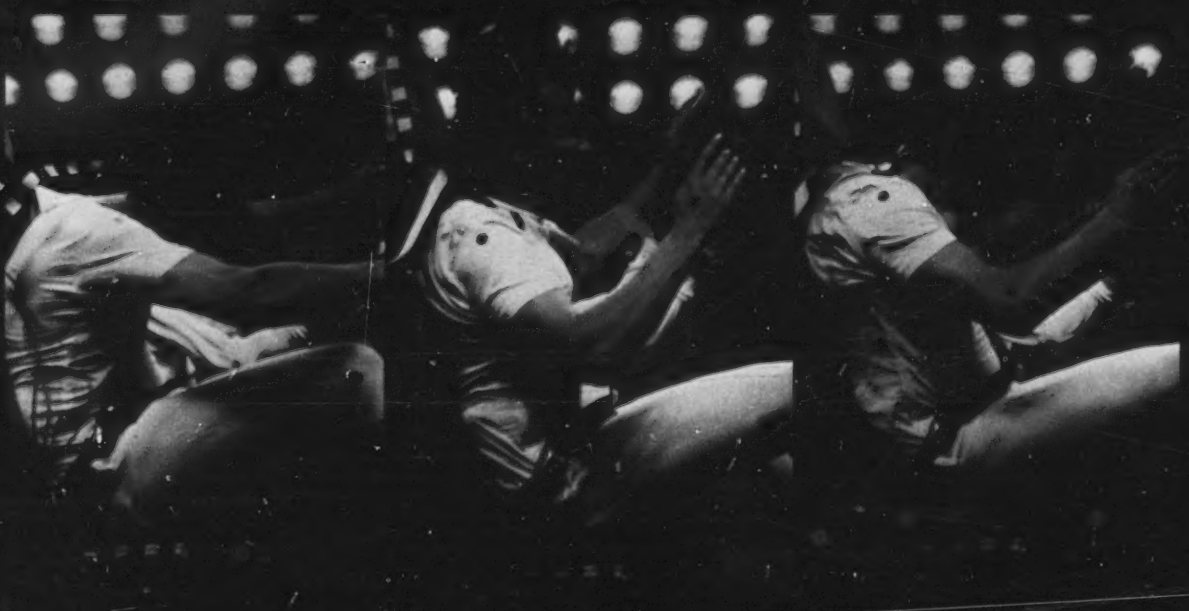
Research engineer Michael Walsh awaits his ride on a crash simulator sled.

2

Impact! Walsh is thrown forward. The seat belt keeps him in his seat.

3

Here the forces of the collision are at their maximum. Notice the bulging of Walsh's stomach as the seat belt strains to hold him back.



4

The human collision has been avoided and Walsh's body begins to rebound.

5

Less than 1/10 of a second after impact, Walsh safely returns to his original position.

6

The speed of this simulated barrier collision was 17 mph!

Evidence From Real Accidents

Seat belts reduce injuries to dummies and to humans in laboratory settings, but this alone does not prove that they help people in real accidents. Real accidents are much more complex than controlled laboratory collisions. Nevertheless, actual accidents have been studied and the findings all point to the benefit of seat belts.

Some of these studies involved on-the-scene investigations of accidents by teams of engineers and doctors. The forces involved in each collision are estimated from the damage sustained by the outside of the car. Damage to the occupants and to the interior of the car are matched to determine the exact cause of injury. These accident investigation studies have all concluded that about half the deaths and serious injuries would have been avoided if lap and shoulder belts had been worn.

One study looked at all the fatal accidents in Metropolitan Toronto in 1970. During that year, 35 drivers and 22 passengers were killed. None of them were wearing seat belts. This investigation concluded that more than half the deaths of both passengers and drivers could have been prevented if seat belts had been worn.

When large numbers of accident records were surveyed, it was again found that seat belts reduced injury and death by about half. One major study of 28,000 accident records was conducted in the mid-1960's in Sweden. This study included all kinds of accidents, serious and minor, but only one make of car was involved. All vehicles were equipped with three-point lap and shoulder belts. The study found that belted people received about half as many injuries as unbelted people in collisions at all speeds. As expected, the greatest reductions were in head, face and chest injuries. No one wearing a seat belt was killed in any collision at speeds up to 60 miles per hour. Unbelted people were killed in collisions at speeds less than 20 miles per hour.

The Swedish study is the most widely known of its type. However, similar studies have been conducted in North America and all have found that belts save lives and reduce injuries in all types of real collisions. Much of the benefit from belts in real accidents is due to the dramatic effect of lap and shoulder belts in reducing the most common injuries — those to the head and chest.

A study of 1,355 accidents in recent model North American cars showed that belted drivers are less likely to be involved in accidents in which a second impact or collision takes place. Usually this second impact involves another motor vehicle or a pedestrian. Seat belts help the driver to remain in his seat and in control of the car during and after a collision or violent manoeuvre. The use of seat belts can thus prevent the additional injuries and vehicle damage that would result from a second collision.

Real accidents are more complex than controlled laboratory collisions.

Accidents are investigated by specialized teams to determine the causes of injuries or death.

Mandatory Seat Belt Use

Since the early 1970's, a number of countries have introduced mandatory seat belt use. Dramatic increases in seat belt use have resulted. In every case, this increase has lead to significant reductions in deaths and injuries in motor vehicle accidents.

In Australia, drivers and front-seat passengers have been required to wear seat belts since 1970. Belt wearing rates (in cars that had belts installed) in all Australian states increased from approximately 20% before the law was passed to approximately 70% three years later. Since 1973, there has been a steady increase in belt use to 90% in 1976. Victoria and New South Wales have achieved and maintained a better than 20% drop in deaths.

Similarly, in New Zealand, increased belt use has been responsible for reducing fatalities to drivers and front-seat passengers. Fatalities to other passengers, who were not required to wear seat belts, have increased. Injuries, especially head injuries, shock and injuries caused by striking the windshield decreased when seat belts were worn.

Finland, Sweden, Norway, Belgium and the province of Ontario have all recently experienced increased usage rates and corresponding reductions in injuries and deaths from motor vehicle accidents. In Finland, it was found that 88% of drivers observed were wearing belts. Sweden measured 84% belt use for front-seat passengers and the number of seriously injured occupants in car accidents has been reduced by 46%. During the first four months of mandatory seat belt use, Belgium has also reported decreases in deaths and injuries. Deaths were down 53.8%, severe injuries were down 28% and minor injuries 20.9%. Preliminary findings in Ontario indicate that belt use has increased from 17% before the law was passed to 66% six months later. For the first six months of 1976, when the use of seat belts was mandatory in Ontario, the number of deaths was 21% below the number predicted on the basis of ten years' fatality figures.

SEAT BELTS AND CHILDREN

The body of a child is different from the adult in a number of ways. The skull is softer and much larger in proportion to the rest of the body. The rib cage is thinner and more elastic. The young child's prominent abdomen provides only limited protection to the large internal organs. Unlike the adult, the child has a pelvis with broad gentle contours. The prominent crests which can provide an anchor point and contact area for the lap belt do not develop until approximately age 10. These factors make it important that special consideration be given to providing crash protection for the infant and child.

The small child's heavy head and fragile skull make him very likely to suffer serious head injuries even in low-speed accidents. Also, children are often allowed to ride in positions in the car which greatly increase their chances of injury. If there is a crash or a sudden stop a youngster standing on the seat becomes a missile striking some part of the vehicle's interior; a child leaning out a window will be wholly or partially ejected; and a baby sitting on an adult's lap can be crushed against the dashboard or seat back.

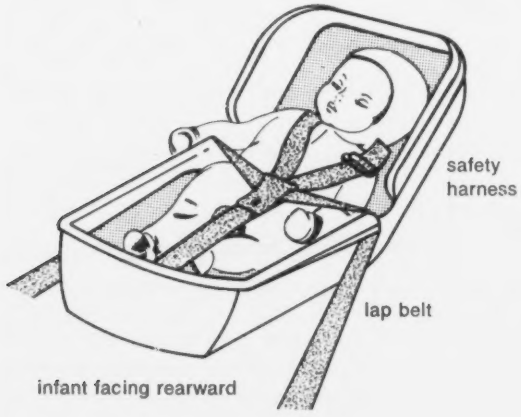
13.8 percent of car passengers killed or injured in Canada in 1974 were under the age of fifteen. In order to provide adequate protection for this age group, children in three size categories require specific consideration.

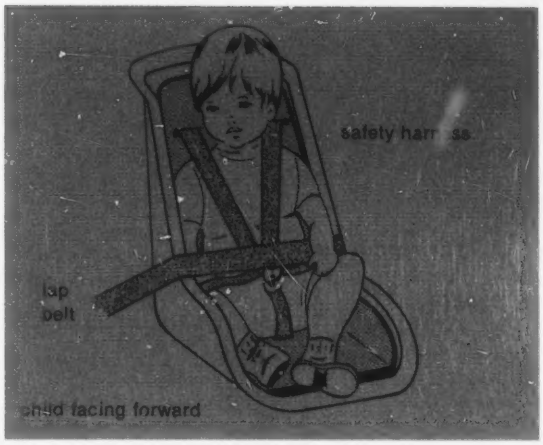
I Infants — less than 20 lbs.

Infants weighing less than 20 lbs. need the protection provided by rear-facing seats which are anchored by the adult lap belt.

In this seat the infant faces the rear of the car and the deceleration forces are spread over a very large proportion of the infant's body.

As a general rule, children should always ride in the rear seat of a car. However, the rear-facing infant seat *does* provide protection which enables it to be used in the front seat.





II Children — between 20 and 40 lbs.

Children weighing between 20 and 40 lbs. should use *properly installed* child restraints which have been tested and proven effective in providing crash protection. There are two basic designs for children of this size.

A. Seats With Harnesses

The five-point safety harness, an integral part of this design, spreads the forces of the impact over the strongest parts of the child's body. The crotch strap, or lowest point of the harness, keeps the webbing down on the pelvic bones, preventing it from riding up over the tummy and putting pressure on the abdominal organs.

This type of seat is anchored to the car in two places: (1) around or through the centre by the adult lap belt; and (2) from the top back by a top anchor strap. It is essential that both of these two anchor points be utilized to prevent both the upper and lower portions of the seat from flying forward carrying the child with them. Installation of these seats and anchor points should be strictly in accordance with the manufacturers' instructions. In some cars, station wagons, and pick-up trucks, installation of the top anchor strap may be difficult or impossible. When this is the case, an approved seat that does not require a top anchor strap might be available.

B. Seats With Protective Shields

This design allows the forces of a collision to be distributed over a very large area of the body, thus greatly reducing the chance of injury. A restraint of this type may have the advantage of not requiring a top anchor strap — it is anchored solely by the lap belt. This makes it convenient to use and adaptable to a variety of vehicles. This type of seat gives maximum protection when used in the centre of the seat.

III Older Children

Children over the age of 5, or weighing over 40 lbs. can wear a regular lap belt. However, until age 10 a child's pelvis has not yet developed the prominent boney structure which readily holds the lap belt in place. Care must therefore be taken to prevent the lap belt from moving up off the pelvic bones and applying pressure to the abdomen. When this happens under impact it is called "submarining" and can cause serious bruising of internal organs.

Be sure that the lap belt is snug and low over the hips — it should never be worn over the tummy.

Pillows and cushions between child and belt, or between child and seat can also cause "submarining" and should be avoided — with one possible exception. A firm support can be used under a child to raise him or her a few inches if the following precautions are observed:

(1) the support must be of very firm non-flammable material — the lighter it is, the easier it is to anchor;

(2) the support must be anchored securely to the seat to prevent it from flying out from under the child during a crash.

A properly fitted shoulder belt may be worn, along with the lap belt, by older children.

Children, like adults, often resist using a restraint system when they are first introduced to it. Youngsters, however, very quickly come to develop a feeling of comfort and security in a child restraint. To achieve this, the restraint must be used *everytime* the child rides in the car. An explanation of what the restraint does and how it works often helps. After a week or so of resistance, most children happily accept their restricted mobility and enjoy having their own special place to sit and ride safely.

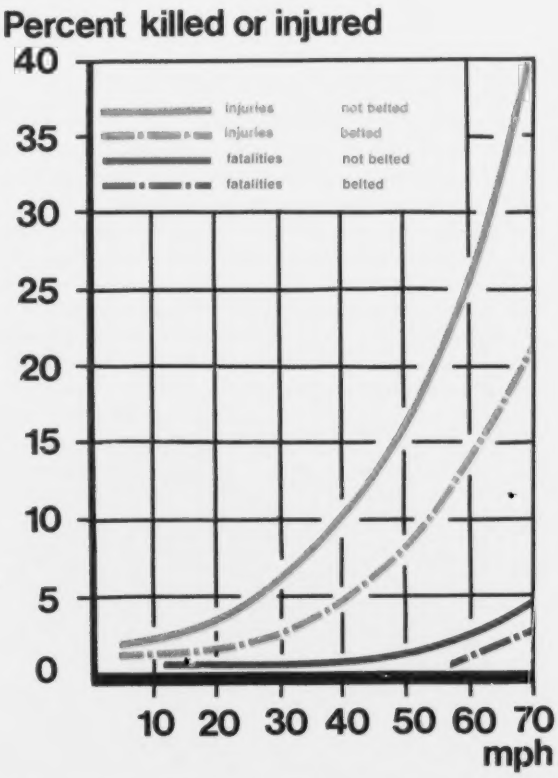
As in many other situations, children need the care and protection of a responsible adult when riding in a car. A child seated in the appropriate restraint device is safe and well cared for; an unrestrained child has been neglected and is in danger.

Whether using child restraints or regular lap belts, and especially if unrestrained, children should always ride in the rear seat.

IN ALMOST EVERY CASE IT'S BETTER TO WEAR SEAT BELTS

In Canada in 1974, 2,529 drivers died in accidents. The death rate for unbelted drivers was about 2.38 per 1,000 accident-involved drivers. The death rate for belted drivers was only .85 per 1,000. These figures are consisent with studies done elsewhere that show that belts reduce the chances of death by more than half. They also show that belts cannot save everybody in all collisions. Of the few belted drivers killed, some were undoubtedly wearing only lap belts and might have been saved if they had worn both lap and shoulder belts.

Seat belts are more effective in some kinds of collisions than others. They provide more protection in head-on and front-angled accidents and rollovers than in side or rear-end collisions. However, it has been shown that vehicle occupants are better off in a side collision if they are wearing their seat belts. They also tend to be more effective at speeds of less than 60 miles per hour. Seat belts cannot always prevent fatal injuries in extremely high-speed accidents or those which involve direct contact with an object, such as a tree, entering the car passenger compartment. Nevertheless, safety experts are unanimous that seat belts are of some benefit in nearly all accidents.



A Swedish study showed that belted people received about half as many injuries as unbelted people in collisions at all speeds. (N. I. Bohlin, 1967)

The Dangers of Being "Thrown Clear"

The human collision can also take place outside the car – if the person goes out through the windshield, side window or door. Some people claim that it is safer to be "thrown clear" during a collision. Careful research has shown that the risk of death or serious injury is many times greater if the person is thrown out of the car.

About one-quarter of all passenger and driver deaths result from being thrown out. One study estimated that about 80 percent of these deaths could have been prevented if the person had stayed in the car.

Those who believe that it is safer to be thrown out of the car should consider why motorcycle accidents are so dangerous. Motorcyclists suffer an extremely high rate of injury and death in their accidents because they are "thrown clear" nearly every time.

The world outside the car is very dangerous for a fast-moving, unprotected human body.

The Importance of Remaining Conscious

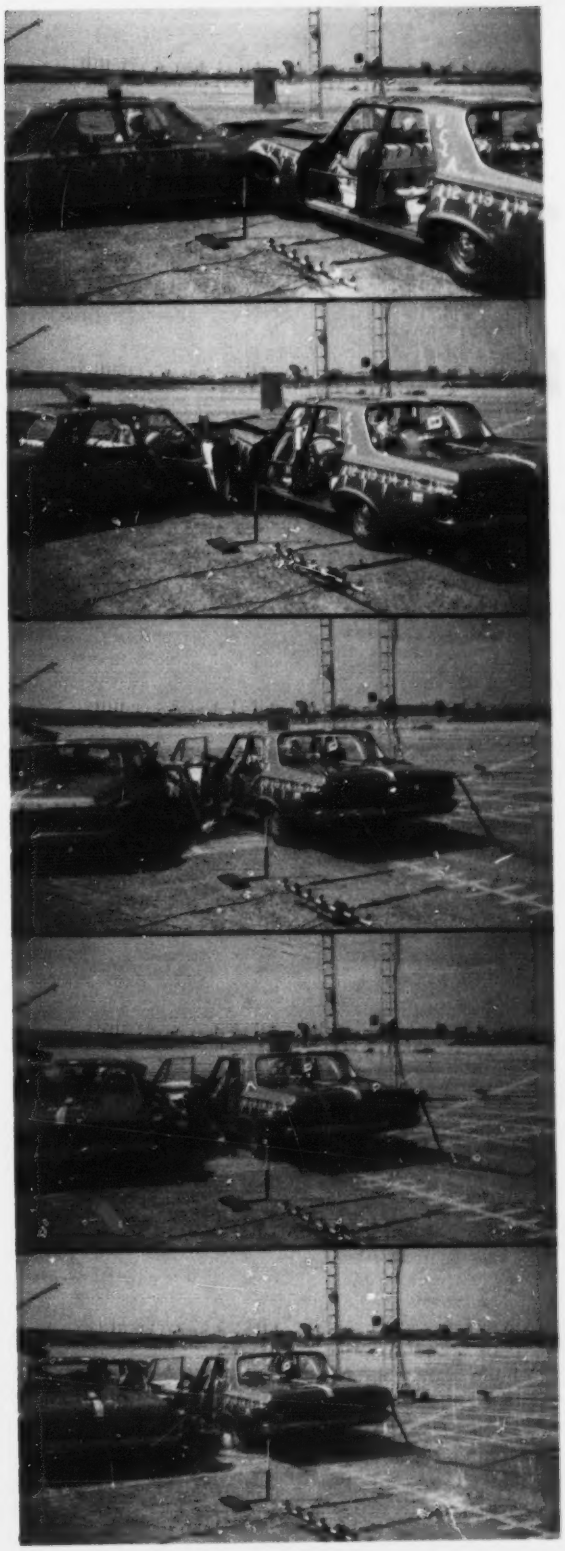
People often say they don't wear their belts because they are afraid of being trapped in a burning car or a car submerged in water. Actually, the occurrence of fire or submersion is rare, especially when compared to the danger of the human collision which occurs in almost every accident. Rather than trapping the occupants, seat belts help them remain conscious and thus able to get out of the car quickly. You cannot escape from a burning or sinking car if you are lying on the floor with a fractured skull.

A study of belted drivers who were killed in motor vehicle accidents in Ontario between 1972 and 1975 found that very few died in a car that burned or was submerged in water. During this four year period, 175 belted drivers died in traffic accidents. Of these, only 3 died in a burning or submerged car. In 1973 and 1975, *no* belted drivers died as a result of fire or water! Most of the 175 died in high speed head-on and side collisions. It is likely that most of these accidents were just so severe that they were unsurvivable. However, some of the drivers might have been saved if they had been using their shoulder belt as well as their lap belt.

The Importance of Being Properly Belted

Belted occupants may occasionally receive injuries from the belts themselves. These injuries are usually minor. Bruises, slight rib fractures, and muscle strain and soreness are much more acceptable than the injuries which occur when vehicle occupants are not wearing seat belts.

The occasional intra-abdominal injury from lap belts usually results from incorrect adjustment; wearing the lap belt too loose, or too high on the abdomen. The belt should be worn snug and as low as possible on the hips. Newer lap belts are auto-



This car was involved in a rollover accident. The driver was fatally injured as a result of being thrown out the back window and the car rolling over her.

matically adjusting and it is less likely that improper adjustment and related injuries will occur with these belts.

If the lap belt does not fit due to seat position or a person's size, an extension has been made available by the automobile manufacturers and can be purchased from a dealer.

Shoulder belts are best suited for people 4′ 11″ in height or taller. The shoulder belt fits properly when the webbing passes over the near shoulder, across the collarbone, and diagonally across the chest towards the far hip. It may have an inch or two slack for comfort. The shoulder belt should never be worn under the arm.

People shorter than 4′ 11″ or very tall people may find it difficult to get a proper fit with some shoulder belts, but this is primarily a problem of comfort rather than one of safety. Accident investigations have found that the shoulder belt does not cause serious neck injuries, as some people fear. The shoulder belt may cause bruises and minor fractures, but these are far less damaging than the head and face injuries received from not wearing it.

Unlike other questions involving seat belts, there has been some controversy among experts as to whether pregnant women should wear seat belts. The medical profession now supports the use of lap and shoulder belts by pregnant women. The most frequent cause of death in car accidents for an unborn child is the death of the mother. The best way to protect the unborn child is to ensure the safety of the mother. Seat belts worn properly (lap belt low under the abdomen) provide considerable protection for pregnant women.

Are Belts Necessary At All Times?

Many people wear seat belts only on long trips or when weather conditions seem particularly dangerous. Serious accidents, however, occur at all speeds, on all kinds of trips and under all kinds of conditions.

The accident rate is low on expressways where much high-speed, long-distance travel takes place. Short trips on urban and rural roads are potentially more dangerous even though the traffic speeds are lower. Most people drive locally a great deal more than they drive long distances. Thus, the chances of being in an accident close to home are greater.

Many accidents occur when visibility is poor or roads are slippery, but most serious accidents, those that cause injury or death, occur under clear and dry conditions. The majority of fatal accidents take place at moderate speeds. More fatal accidents occur in the late summer and early fall months when the weather is usually favorable, than in winter months.

Some of the earlier belt designs have been inconvenient for the user. However, the evidence clearly indicates that seat belts are worth the trouble it takes to wear them. Design requirements for 1974 and later cars have made belts more comfortable and easier to wear.

The only way to gain full benefit from seat belts is to make a habit of using them on every trip.

PERSONAL RISK

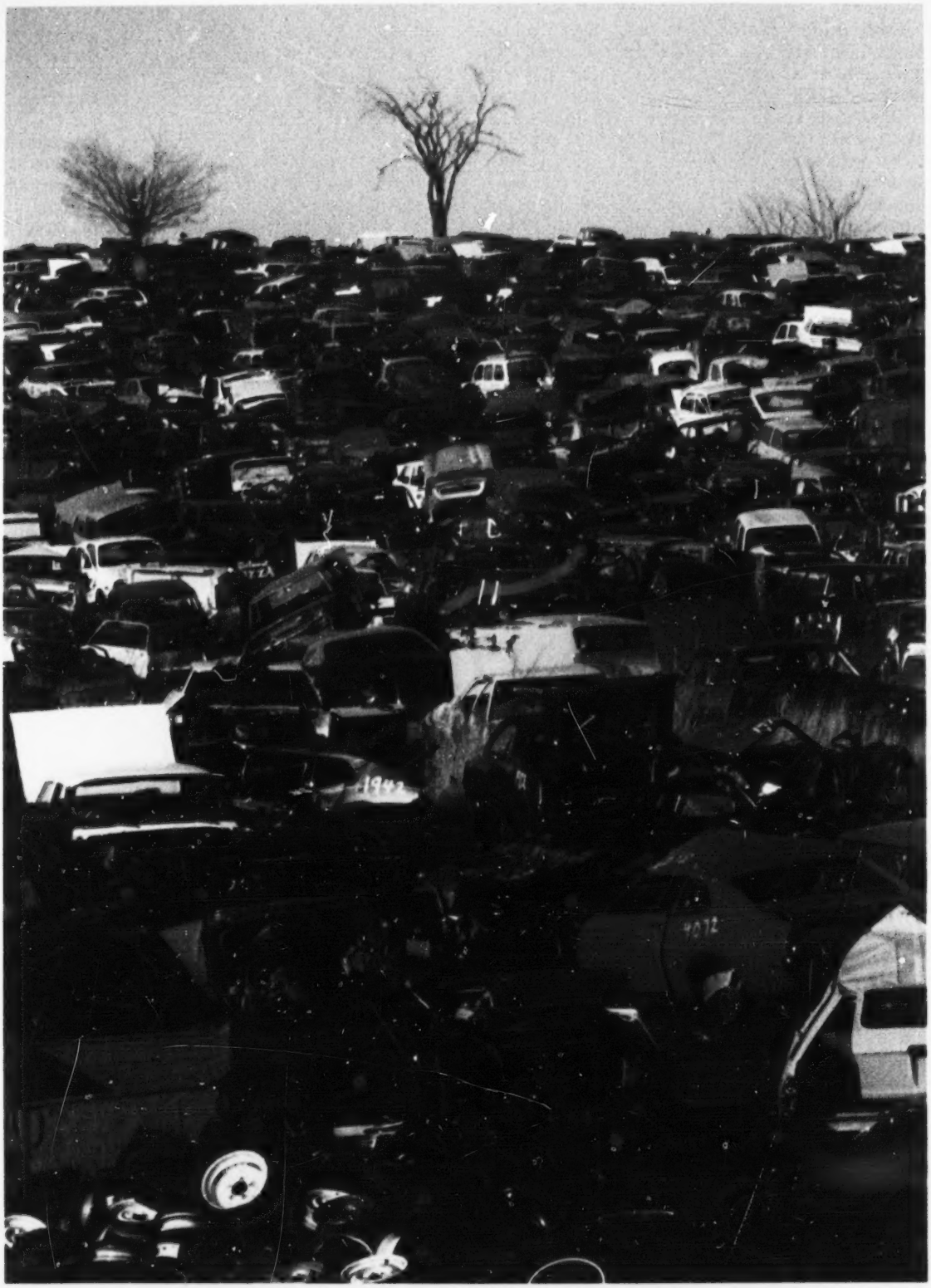
Every person who uses the roads risks injury or death. It is certainly not pleasant to contemplate the possibility of being killed each time you drive your car, but the risk is real.

Of all the people now living in Canada in 1975, 10.1 percent (2,260,000) will be killed or injured in a motor vehicle accident within the next ten years. Over the next forty years, 34 percent of the current population will be killed or injured. That's more than 7,684,000 people.

Over a lifetime, a person has more than a fifty/fifty chance of being injured in a car accident. There are many things that will reduce your own risk. You can drive very carefully. You can avoid driving after drinking. You can keep your car in peak condition. You could even drive less. None of these steps, however, will guarantee that you won't have an accident.

Good drivers have accidents too, sometimes because they are hit by drunk drivers or other poor drivers, sometimes because they make an error. Nobody is immune to accidents.

No one can control all of the factors involved in a traffic collision. But there is a simple and effective way of cutting your risk by more than half — *wear your seat belts.*



BIBLIOGRAPHY

WHAT HAPPENS IN A COLLISION

The Human Collision

Huelke, D. F., H. W. Sherman and J. O'Day. "The Hazard of the Unrestrained Occupant", *Eighteenth Conference of the American Association for Automotive Medicine,* Toronto, Ontario, Canada, Sept. 12-14, 1974, pp. 1-14.

MacKay, G. M. and C. P. de Fonseka, "Some Aspects of Traffic Injury in Urban Road Accidents", *Eleventh Stapp Car Crash Conference Proceedings,* Society of Automotive Engineers, New York, N.Y., U.S.A., 1967, pp. 70-78.

Mortality from Motor Vehicle Traffic Accidents, Ontario 1966-1970, Special Report No. 49, Ministry of Health, Ontario Government, Toronto, Ontario, Canada, 1973.

Muller, G., "Why A Second Collision", in *Prevention of Highway Injury,* Selzer, M. L., Gikas, P. W., Huelke, D. F. (ed) Highway Safety Research Institute, University of Michigan, Ann Arbor, Michigan, U.S.A., 1967, pp. 272-284.

Tourin, B., "Ejection and Automobile Fatalities", *Public Health Reports,* May 1958, Vol. 73, pp. 381-391.

SEAT BELTS PREVENT THE HUMAN COLLISION

It's Not The Fall — It's The Stop At The End

DeHaven, H., "Mechanical Analysis of Survival in Falls From Heights of Fifty to One Hundred and Fifty Feet", *War Medicine,* 1942, Volume II, pp. 586-596.

Lhotka, D. C., *Automotive Restraint Systems* — Development and Use, Paper from Human Factors Society Symposium, 1971, National Safety Council, 425 North Michigan Avenue, Chicago, Illinois, 60611, U.S.A., 1968.

How Much Can People Take?

Stapp, J. P., "The Problem: Biomechanics of Injury", in *Prevention of Highway Injury,* Selzer, M. L., Gikas, P. W. and Huelke, D. F. (ed), 1967, Highway Safety Research Institute, University of Michigan, Ann Arbor, Michigan, U.S.A., pp. 159-164.

Laboratory Evidence

Bohlin, N. I., "Studies of Three-Point Restraint Harness Systems in Full-Scale Barrier Crashes and Sled Runs" *Eighth Stapp Car Crash Conference and Field Demonstration,* Wayne State University Press, Detroit, Michigan, U.S.A., 1966, pp. 258-320.

Cichowski, W. G. and J. N. Silver, *Effective Use of Restraint Systems in Passenger Cars,* Society of Automotive Engineers, SAE No. 680032, New York, N.Y., U.S.A., 1968.

Grush, E. S., S. E. Henson and O. R. Ritterling, "Restraint System Effectiveness", *Highway Research Board Record No. 420,* Transportation Research Board, Washington, D.C., U.S.A., 1972, pp. 16-29.

Evidence From Real Accidents

Baker, L. L., *Drivers Wearing Seat Belts Are Less Likely to be Involved in Multiple Impact Accidents,* Automotive Safety Bulletin, Chrysler Corporation, September 1972.

Bohlin, N. I., "A Statistical Analysis of 28,000 Accident Cases with Emphasis on Occupant Restraint Value", *Eleventh Stapp Car Crash Conference Proceedings,* Society of Automotive Engineers, New York, N.Y., U.S.A., 1967, pp. 299-308.

Huelke, D. F. and W. A. Chewning, *Comparison of Occupant Injuries With and Without Seatbelts,* SAE No. 690244, Society of Automotive Engineers, New York, N.Y., U.S.A., 1969.

Kihlberg, J. K., *Efficacy of Seat Belts in Injury and Non-Injury Crashes in Rural Utah,* Report VJ-2721-R3, Calspan, P.O. Box 235, Buffalo, N.Y., 14221, U.S.A., May 1969.

Levine, D. N. and B. J. Campbell, "Effectiveness of Lap Seat Belts and the Energy-absorbing Steering System in the Reduction of Injuries", *Journal of Safety Research,* September 1972, Volume 3, No. 4, pp. 106-118.

Sherman, H. W., *Case Results of Some 1974 Passenger Car Crashes,* Eighteenth Conference of the American Association for Automotive Medicine, Toronto, Ontario, Canada, Sept. 12-14, 1974, pp. 121-154.

Shortridge, R. M., "A Comparison on Injury Severity Patterns for Unrestrained, Lap Belted and Torso Restrained Occupants in Automobile Accidents", HS-014519, *Proceedings of 17th Conference of the American Association for Automotive Medicine,* Oklahoma City, Oklahoma, U.S.A., 1973, pp. 130-147.

Siegel, A. W., W. T. VanWagoner, and A. M. Nahum, *Case Comparison of Restrained and Unrestrained Occupants and Related Injury Patterns,* Society of Automotive Engineers, SAE No. 69024, New York, N.Y., U.S.A., 1969.

Wilson, R. A. and C. M. Savage, *Restraint System Effectiveness — A Study of Fatal Accidents,* Automotive Safety Engineer Seminar, 1973, Environmental Activities Staff, G. M. Corp., Warren, Michigan, U.S.A.

Mandatory Seat Belt Use

Andreassend, D. C., *The Effects of Compulsory Seat Belt Wearing Legislation in Victoria,* National Road Safety Symposium, March 1972, Canberra, Australia.

Foldvary, L. A., and J. C. Lane, *The Effectiveness of Compulsory Wearing of Seat Belts in Casualty Reduction,* Accident Analysis and Prevention, Vol. 6, pp. 59-81, Pergamon Press, 1974, Great Britain.

Henderson, Michael and Kathleen Freedman, *The Effect of Mandatory Seat Belt Use in New South Wales, Australia,* Traffic Accident Research Unit, Department of Motor Transport, New South Wales, Australia, March 1974.

Oranen, Liisa, *Use of Safety Belts Investigation into the Effect of Obligatory Use of Safety Belts on the Volume of Use,* Liikenneturva, Central Organization for Traffic Safety, Iso Roobertinkatu 20, 00120 Helsinki 12, Finland, 1975.

Palmer, Ross M. and J. B. Toomath, *An Interim Evaluation of the Compulsory Seat Belt Law,* Traffic Engineering Section, Road Transport Division, Ministry of Transport, Private Bag, Wellington, New Zealand, 1974.

Pierce, J. A., M. E. Toomer, and H. C. Pang, *Seat Belt Use in Ontario.* A Preliminary Report, Ontario Ministry of Transportation and Communications, Systems Research and Development Branch, Downsview, Ontario, Canada, July 1976.

Vaughan, Rodney G., *Investigation of Seat Belt Performance in New South Wales Traffic Crashes,* Traffic Accident Research Unit, Dept. of Motor Transport, New South Wales, Australia, May 1974.

Wilde, G. J. S. and L. Cunningham, *Adoption of Shoulder Belt Use and Changes in Driver Attitudes in Response to the Ontario Seat Belt Legislation. Report on Aggregate Data,* Queen's University, Studies of Safety and Transport, Kingston, Ontario, Canada, May 1976.

Seat Belts and Children

Burdi, A. R., D. F. Huelke, R. G. Snyder and G. H. Lowrey, "Infants and Children in the Adult World of Automobile Safety Design: Pediatric and Anatomical Considerations for Design of Child Restraints", *Journal of Biomechanics,* Vol. 2, Pergamon Press, 1969, pp. 267-280.

Herbert, D. C., B. A. Vazey, J. M. Wyllie, V. Leitis, J. D. Scott, and R. G. Vaughan, *Crash Protection for the Sub-Teen Child,* Traffic Accident Research Unit, Dept. of Motor Transport, New South Wales, Australia, March 1974.

"Infant Carriers and Child Restraints", *Consumer Reports,* March, 1975, pp. 151-154.

Lowne, R. W., *Injuries to Children Involved in Road Accidents,* Transport and Road Research Laboratory, England. Paper presented at IRCOBI International Meeting on Biomechanics of Children, Lyon, Sept. 1974, pp. 19-29.

Melvin J. W. and R. L. Stalnaker, *Basic Design Principles of Child Auto Restraints,* Society of Automotive Engineers, SAE No. 740936, Warrendale, Pa., U.S.A., 1974.

SAE Handbook (1967), *SAE J833a, Table 2,* Society of Automotve Engineers, Warrendale, Pa., U.S.A., 1967.

Shortridge, R. M. and J. O'Day, *A Real World Perspective on Automobile Accidents Involving Small Child Passengers,* Society of Automotive Engineers, SAE No. 740935, Warrendale, Pa., U.S.A., 1974.

Snyder, R. G. and B. O'Neill, "Are 1974-1975 Automotive Belt Systems Hazardous to Children?", *American Journal for Diseases of Children,* Vol. 129, August 1975, pp. 946-949.

IN ALMOST EVERY CASE IT'S BETTER TO WEAR SEAT BELTS

The Importance of Being Properly Belted

Automobile Safety Belts During Pregnancy, Committee on Medical Aspects of Automotive Safety. Journal of the American Medical Association, July 3, 1972, Vol. 221, No. 1, pp. 20-21.

Crosby, W. M. and J. P. Costiloe, "Safety of Lap Belt Restraint for Pregnant Victims of Automobile Collisions", *The New England Journal of Medicine,* May 1971, Volume 284, No. 12, pp. 632-636.

Grime, G., "Accidents and Injuries to Car Occupants Wearing Safety Belts', *Automobile Engineer,* July 1968, pp. 292-300.

Hodson — Walker, N. J., "Value of Safety Belts: A Review", *CMA Journal,* February 28, 1970, Vol. 102, pp. 391-393.

Huelke, D. F. and R. G. Snyder, "Seat Belt Injuries: The Need for Accuracy in Reporting of Cases", *Journal of Trauma,* 1975, Volume 15, No. 1, pp. 20-23.

Porter, S. D. and E. W. Green, "Seat Belt Injuries", *Arch Surgery,* Volume 96, February 1968, pp. 242-246.

SEAT BELT USE AND ATTITUDES

Council, F. M., "Seatbelts: A Follow-Up Study of Their Use Under Normal Driving Conditions", *Journal of Safety Research,* 1969, Volume 1, No. 3, pp. 127-136.

Fhaner, G. and M. Hane, "Seatbelts: Factors Influencing Their Use", *Accident Analysis and Prevention,* Pergamon Press, Great Britain, 1973, Volume 5, pp. 27-43.

Hix, R. L. and P. N. Ziegler, *1974 Safety Belt Survey,* DOT HS801224, U.S. Department of Transportation, NHTSA Research and Development, Washington, D.C., U.S.A., 1974.

Lonero, L. P., W. T. Wilson and D. M. Ish, *The Seatbelt Education Project,* RR187 Ministry of Transportation and Communications, Research & Development Division, Downsview, Ontario, Canada, 1973.

Robertson, L. S., B. O'Neill and C. W. Wixom, "Factors Associated with Observed Safety Belt Use", *Journal of Health & Social Behaviour,* 1972, Volume 13, pp. 18-24.

GENERAL INFORMATION ON SEAT BELTS

Griffin, L. I., *Analysis of the Benefits Derived from Certain Presently Exsting Motor Vehicle Safety Devices: A Review of the Literature,* University of North Carolina, Highway Safety Research Center, Chapel Hill, North Carolina, U.S.A., 1973.

Highway Traffic Collisions, 1975, Ministry of Transportation and Communications, Downsview, Ontario, Canada.

Lalonde, Marc, *A New Perspective on the Health of Canadians:* A Working Document, Ministry of National Health and Welfare, Ottawa, Ontario, Canada, April 1974.

Motor Vehicle Traffic Accidents, 1974, Statistics Canada, May 1976, Catalogue No. 53-206, Ottawa, Ontario, Canada.

Snyder, R. G., *A Survey of Automotive Occupant Restraint Systems: Where we've been, where we are, and our current problems,* Society of Automotive Engineers, SAE 690243, New York, N.Y., U.S.A., 1969.

The Case for Seat Belts, U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C., U.S.A., 1973.

The Seat Belt Argument, Canada Ministry of Transport, Road and Motor Vehicle Traffic Safety Branch, Ottawa, Ontario, Canada, 1974.

TP 454
CTS-2-76

Transport Canada
Transports Canada

Road Safety
Sécurité routière